REMARKS/ARGUMENTS

Claims 1 and 27 have been amended to correct some minor typographical errors noted by the Applicant. Claims 1-50 are pending in the application.

Claim Rejections 103(a) – Tsujido and Stam

Claims 1-5 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Tsujido et al. (USPN 5,471,565) (hereinafter "Tsujido") in view of Stam (USPN 6,246,416) (hereinafter "Stam").

As amended, Claim 1 recites:

> A computer rendering method comprising:
> moving a semitransparent plane including a plurality of reflection points relative to an axis; and
> rendering an image of the plurality of reflection points at a plurality of positions with respect to the axis such that each said point maps an elongated, continuous image.

Thus, the computer rendering method moves a semitransparent plane relative to an axis. This semitransparent plane includes multiple reflection points. The computer rendering method renders an image of these reflection points at positions with respect to the axis such that each of the reflection points on the semitransparent plane maps an elongate, continuous image. An example of such a computer rendering method is graphically illustrated in Fig. 8a-c of the Applicant's Application. Neither Tsujido nor Stam discloses or suggests the computer rendering method recited in Claim 1.

Tsujido describes a method of displaying a rotary body as a realistic picture image by showing the projected and recessed surfaces of the body and shading

those surfaces in a realistic manner. (See Tsujido, col. 2, lines 19- 57). This method described by Tsujido is significantly different from the computer rendering method recited in Claim 1. For example, although Tsujido describes surfaces of a rotary body, Tsujido does not disclose moving a semitransparent plane relative to an axis. Also, the computer rendering method recited in Claim 1 renders an image of the reflecting points such that each point maps an elongated, continuous image. In contrast, to display an image of the rotary body, the method in Tsujido uses the projected and recessed surfaces of the body, not reflecting points at positions with respect to an axis. Also, the surfaces in Tsujido are used to display a rotary body, not to map an elongated, continuous image as recited in Claim 1.

The Office Action asserts that Tsujido discloses rotating a rotary body perpendicular to a rotational axis and that a particular point P in that rotary body has a reflection factor R. The Office Action also asserts that Tsujido discloses displaying a picture image with respect to the external line of a cross-section which passes through the rotational axis. (See Office Action, page 2). The point P referred to by the Office Action is a hypothetical point on the rotary body that is used in Tsujido to discuss the reflection of light off the rotary body at a particular point. (See Tsujido, Fig. 3). Assuming, for the sake of argument, that the Office Action's assertions are correct, Tsujido merely discloses displaying a rotary body with respect to a line in the body's cross-section where the body has some reflective characteristics. However, Tsujido fails to disclose or suggest moving a semitransparent plane or rendering an image of reflection points with respect to the axis where each point maps an elongated, continuous image, as recited in Claim 1.

The Office Action acknowledges that Tsujido does not teach rendering image of reflection points. The Office Action argues that Stam teaches this element. Stam describes a method for modeling reflection of light from an anisotropic surface. This method of modeling involves calculating the distribution of reflected light relative to the incoming light at a particular reflecting point on the anisotropic surface. (See Stam, col. 3, lines 50-59). However, the reflecting point described by Stam is not included in a semitransparent plane. Nor does the reflecting point in Stam map an elongated, continuous image. Thus, the reflecting point in Stam is not equivalent to the reflecting point as recited in Claim 1.

Even if Tsujido and Stam can be properly combined, the combination is merely a method for realistically displaying surfaces of a rotary body where the surfaces are anisotropic and can reflect light. However, nothing in Tsujido or Stam discloses or suggests the computer rendering method as recited in Claim 1.

For at least the above-identified reason, Applicant respectfully submits that Claim 1 is patentable over Tsujido and Stam, alone or in combination, and is allowable. Since Claims 2-5 depend from Claim 1, Applicant respectfully submits that Claims 2-5 are also allowable for at least the same reasons.

<u>Claim Rejections 103(a) – Tsujido, Stam, and Gröller</u>

Claims 6-7 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Tsujido in view of Stam, and in further view of Gröller et al. ("Modeling and Visualization of Knitware", IEEE 1995, pages 302-310) (hereinafter "Gröller").

Claims 6 and 7 recite:

> 6. The computer rendering method as defined in Claim 1, wherein:

a plurality of control points, each being located at an intersection of two axes, define a three-dimensional (3D) surface of a macrostructure;

moving the semitransparent plane including the plurality of reflection points relative to the axis further comprises rotating and translating the plane of the reflection points respectively about and along each said axis of the 3D surface of the macrostructure; and

rendering the image of the plurality of reflection points further comprises rendering a 3D model from a plurality of images of a plurality of positions of the planar plurality of reflection points with respect to each said axis of the 3D surface of the macrostructure.

7. A computer-readable media comprising computer-executable instructions for performing the computer rendering method as recited in Claim 1.

As discussed above, neither Tsujido nor Stam discloses or suggests moving a semitransparent plane that includes reflecting points, rendering an image of the reflecting points at positions with respect to an axis, or a reflecting point that maps an elongated, continuous image, as recited in independent Claim 1. Gröller fails to cure these deficiencies.

Gröller describes a method for modeling and visualizing knitwear using volumetric data. In particular, the frequency of fibers in a certain region of the knitwear is reflected by a density value. (See Gröller, page 304). However, Gröller does not disclose or suggest rendering an image of reflection points at positions with respect to an axis such that each point maps an elongated, continuous image, as recited in independent Claim 1. For at least these same reasons, Applicant respectfully submits that dependent Claims 6 and 7 are patentable over Tsujido, Stam and Gröller, alone or in combination, and are allowable.

Furthermore, Gröller acknowledges that the method is not applicable for mapping knitted fabrics onto free-form surfaces. (See Gröller, page 310). Thus,

since the modeling method described in Gröller cannot map fabric structures onto free-form surfaces, Gröller also fails to disclose rotating and translating the plane of the reflection points respectively about and along each axis of a <u>3D surface</u> of the macrostructure, and rendering a 3D model from images of positions of the planar reflection points with respect to each axis of a <u>3D surface</u> of a macrostructure, as recited in dependent Claim 6.

Thus, even if Gröller can be combined with Tsujido and Stam, the resulting combination is merely a method for realistically displaying two dimensional surfaces of a body where the surfaces can reflect light and are associated with some volumetric data for modeling and visualization. However, this combination does not disclose or suggest the computer rendering method recited in Claim 6. Applicant respectfully submits that Claim 6 is patentable over Tsujido, Stam and Gröller, alone or in combination, and is allowable for at least these additional reasons.

<u>Claim Rejections 103(a) –Gröller and Westin</u>

Claims 8-32 and 36-46 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Gröller in view of Westin et al. ("Predicting Reflectance Functions from Complex Surfaces", ACM published 1992) (hereinafter "Westin").

Claim 8 recites:

> A modeling method comprising:
> generating a macrostructure for a three-dimensional (3D) object defined by a plurality of axes; and
> applying a semitransparent microstructure, defined by planar plurality of reflection points, to the macrostructure by moving the plane of the reflection points with respect to each said axis to yield a 3D model.

Thus, the modeling method in Claim 8 applies a semitransparent microstructure defined by planar reflection points to a macrostructure for a three-dimensional object defined by axes. The microstructure is applied to the macrostructure by moving the plane of the reflection points with respect to each axis to yield a 3D model. Gröller and Westin fail to disclose or suggest this method of generating a 3D model.

As discussed above, Gröller describes a method for modeling and visualizing knitwear using volumetric data. This method disclosed by Gröller cannot map fabric structures onto free-form surfaces. To render a model with fabrics, the Gröller method has to tile quadrilaterals that simulate the fabrics onto an image plane of the model. (See Gröller, page 305 to 306; and Fig. 9a-b and 11a-b). Unlike the method described in Gröller that approximates the model by tiling, the method recited in Claim 8 yields the 3D model by moving the plane of reflection points with respect to each axis of the 3D object. Thus, the method described in Gröller is significantly different from the modeling method recited in Claim 8.

The Office Action acknowledges that Gröller does not teach transparent model. But the Office Action argues that Westin teaches the modeling of "microgeometries that include transparent materials". (See Office Action, page 4). Westin describes a method for predicting reflectance functions from complex surfaces. However, nothing in Westin discloses or suggests a semitransparent microstructure that is defined by planar reflection points and that is applied to a macrostructure by moving the plane of the reflection points with respect to each axis of a 3D object, as recited in Claim 8.

Even if Gröller and Westin can be combined, the combination would only yield a method for modeling microgeometries with transparent materials that tiles

the surfaces of the geometries with quadrilaterals and simulates the reflectance of the surfaces. However, the combination fails to disclose or suggest the modeling method recited in Claim 8.

For the above-identified reasons, Claim 8 is patentable over Gröller and Westin, alone or in combination, and is allowable. Given that Claims 9-12 depend from Claim 8, Claims 9-12 are also allowable for at least the same reasons.

Claim 13 recites:

> A method for rendering knitwear, the method comprising:
> generating a macrostructure for a three-dimensional (3D) object defined by a plurality of intersecting axes;
> applying a stitch pattern to each said axis; and
> applying a semitransparent lumislice to each said stitch pattern to yield a 3D knitwear model.

As discussed above, Westin merely describes a method for predicting reflectance on a surface. Gröller describes a method for modeling and visualizing knitwear using volumetric data. But the method disclosed by Gröller cannot map fabric structures onto free-form surfaces. Gröller also describes an analytical model for modeling a yarn that includes a skeleton curve and the cross-sections of different yarn types. (See Gröller, page 304; and Fig. 5, 6 and 7a-c). However, this analytical model is merely used to calculate the volumetric data for indirectly rendering an object with fabrics, not to create a 3D knitwear model using a lumislice.

To render a model with fabrics, the Gröller method has to tile quadrilaterals that simulate the fabrics onto an image plane of the model. Unlike the tiling method in Gröller, the method recited in Claim 13 generates the 3D knitwear model by applying a semitransparent lumislice to each stitch pattern, which is applied to each axis that defines the 3D object. Thus, Gröller and Westin, alone or

in combination, do not disclose or suggest the method recited in Claim 13.

For the above-identified reasons, Claim 13 is patentable over Gröller and Westin, alone or in combination, and is allowable. Given that Claims 14-17 depend from Claim 13, Claims 14-17 are also allowable for at least the same reasons.

Claim 18 recites:

> A method for rendering knitwear, the method comprising:
>
> generating a macrostructure, the macrostructure being defined by the plurality of axes connecting a plurality of control points, each said control point being situated at an intersection of at least two of the axes, the plurality of axes defining a three-dimensional (3D) object;
>
> applying a stitch pattern to each said axis; and
>
> applying a yarn microstructure, defined by a planar plurality of reflection points, to each stitch of the stitch pattern applied to each axis defining the 3D object by rotating and translating the plane of the reflection points perpendicular with respect to each said axis to yield a 3D knitwear model.

As discussed above, although Gröller describes an analytical model for modeling a yarn that includes a skeleton curve and the cross-sections of different yarn types, the method disclosed by Gröller cannot map fabric structures onto free-form surfaces. Thus, Gröller fails to disclose or suggest generating a 3D knitwear model by applying a yarn microstructure to each stitch of a stitch pattern applied to each axis of a 3D object by rotating and translating the plane of the reflection points perpendicular with respect to each axis, as recited in Claim 18.

For the above-identified reasons, Claim 18 is patentable over Gröller and Westin, alone or in combination, and is allowable. Given that Claims 19-26 depend from Claim 18, Claims 19-26 are also allowable for at least the same reasons.

Claim 27 recites:

> A computer rendering method comprising:
> moving a plurality of voxels contained within parallel opposing planes with respect to an axis that is perpendicular to the parallel opposing planes, each said voxel being semitransparent and having a reflectance factor and a plurality of reflection points having a density; and
> rendering an image of the plurality of voxels at a plurality of positions with respect to the axis such that at least one said point maps an elongated, continuous image.

As discussed above, Gröller describes a method for modeling and visualizing knitwear using volumetric data where the frequency of fibers in a certain region of the knitwear is reflected by a density value. Although Gröller describes the use of a density value, Gröller fails to disclose the use of voxels. As recited in Claim 27, voxels are contained within parallel opposing planes. The voxels are semitransparent and have a reflectance factor and reflection points having a density. Nothing in Gröller discloses anything that is equivalent to a voxel. Thus, Gröller also fails to disclose moving such voxels with respect to an axis that is perpendicular to the parallel opposing planes and rendering an image of the voxels with respect to the axis such that at least one point maps an elongated, continuous image, as recited in Claim 27.

For at least the above-identified reasons, Claim 27 is patentable over Gröller and Westin, alone or in combination, and is allowable. Given that Claims 28-32 depend from Claim 27, Claims 28-32 are also allowable for at least the same reasons.

Claim 37 recites:

> A method for rendering knitwear, the method comprising:
> generating a macrostructure for a three-dimensional (3D) object defined by a plurality of intersecting axes;
> applying a stitch pattern to each said axis;
> applying a yarn microstructure, defined by a plurality of voxels

> contained within parallel opposing planes, to the macrostructure by translating and rotating the plurality of voxels contained within parallel opposing planes perpendicular respectively along and about each stitch of the stitch pattern applied to each said axis, wherein each said voxel is semitransparent and has a reflectance factor and a plurality of points having a density; and
>
> rendering a 3D knitwear model from a combination of images of the plurality of voxels at a plurality of positions with respect to the plurality of axes.

As discussed above, Gröller does not disclose the use of voxels. Thus, Gröller also fails to disclose a yarn microstructure defined by voxels or applying such yarn microstructure to a macrostructure by translating and rotating the voxels contained within parallel opposing planes perpendicular respectively along and about each stitch of the stitch pattern applied to each axis, as recited in Claim 37.

For at least the above-identified reasons, Claim 37 is patentable over Gröller and Westin, alone or in combination, and is allowable. Given that Claims 38-44 depend from Claim 37, Claims 38-44 are also allowable for at least the same reasons.

Claim 45 recites:

> A machine-readable medium having instructions stored thereon for execution by a processor to perform a method for rendering knitwear, the method comprising:
>
> generating a parameterized surface describing a three-dimensional (3D) knitwear macrostructure;
>
> determining a plurality of control points that define the parameterized surface, wherein each said control point is located at an intersection of two axes;
>
> applying a stitch pattern to each of the control points of the knitwear skeleton to form a skeleton of the yarn stitches;
>
> discretizing the skeleton of the yarn stitches into a plurality of discretized yarn segments;
>
> sorting the discretized yarn segments according to a viewing condition of a scene including the knitwear macrostructure and a distance of a view of the scene;

inputting the plurality of discretized yarn segments into:

a geometry of the scene; and

a lighting condition of the scene;

applying a lumislice, with respect to a resolution of the distance of the view of the scene and a sampling density, to each stitch of the stitch pattern of the sorted discretized yarn segments by translating and rotating the lumislice perpendicular to and respectively along and about each stitch of the stitch pattern applied to the plurality of intersecting axes, wherein the lumislice is semitransparent and is computed from a fiber distribution of a yarn cross-section; and

rendering a synthesis of the scene including the knitwear macrostructure using the sorted discretized yarn segments having the lumislice applied thereto, the viewing condition of the scene, and the distance of the view of the scene.

In rejecting Claim 45, the Office Action simply asserts that the claimed features are disclosed in 8 pages of the Gröller reference. (See Office Action, page 7). However, materials in these 8 pages do not disclose or suggest the elements in Claim 45, such as the elements that are related to a scene. In fact, Gröller does not disclose or suggest any material that is related to a scene. Applicant respectfully submits that this rejection is not properly supported and should be withdrawn.

As discussed above, although Gröller describes an analytical model for modeling a yarn that includes a skeleton curve and the cross-sections of different yarn types, the method disclosed by Gröller cannot map fabric structures onto free-form surfaces. Thus, Gröller fails to disclose applying a stitch pattern to each of the control points of the knitwear skeleton to form a skeleton of the yarn stitches where the control points define a parameterized surface. Gröller also fails to disclose the elements in Claim 45 that are related to a scene. For at least the above-identified reasons, Claim 45 is patentable over Gröller and Westin, alone or in combination, and is allowable. Given that Claim 46 depends from Claim 45, Claim 46 is also allowable for at least the same reasons.

Claim Rejections 103(a) –Gröller, Westin and Neyret

Claims 33, 47, and 48 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Gröller in view of Westin, and in further view of Neyret ("Modeling, Animating, and Rendering Complex Scene Using Volumetric Texture", IEEE 1998, pages 55-70) (hereinafter "Neyret").

Claim 33 recites:

> 33. The method as defined in Claim 27, wherein each of the voxels has an associated opacity and voxel reflectance function (VRF).

As discussed above, Gröller fails to disclose moving voxels with respect to an axis that is perpendicular to the parallel opposing planes and rendering an image of the voxels with respect to the axis such that at least one point maps an elongated, continuous image, as recited in independent Claim 27. Although Neyret mentions a reflectance function related to a voxel, the method described in Neyret fails to disclose how such voxel and the associated reflection function are used to render an image, as recited in Claims 27 and 33.

Even if Neyret can be combined with Gröller and Westin, the combination merely includes a method for modeling an object that tiles the surfaces of the object with quadrilaterals and simulates the reflectance of the surfaces with a reflectance function. However, the combination does not disclose or suggest the computer rendering method recited in Claim 33. For at least the above-identified reasons, Claim 33 is patentable over Gröller, Westin and Neyret, alone or in combination, and is allowable.

Claims 47 and 48 recite:

> 47. The medium of Claim 45, further comprising, before applying the lumislice, computing a shadow map from the geometry of the scene and

the lighting condition, wherein the synthesis of the scene is rendered using the computed shadow map.

48. The medium of Claim 45, wherein:
each said lumislice characterizes attributions of a cross-sectional slice of yarn of the yarn stitches that is divided into voxels; and
each of the voxels has an associated opacity and voxel reflectance function (VRF).

As discussed above, although Neyret mentions a reflectance function related to a voxel, the combination of Gröller, Westin and Neyret fails to disclose how such voxel and the associated reflection function are used to render an image. Thus, the combination also fails to disclose how the voxels and reflection function are used to render a scene as recite in Claims 47 and 48. For at least the above-identified reasons, Claims 47-48 are patentable over Gröller, Westin and Neyret, alone or in combination, and are allowable.

Claim Rejections 103(a) –Gröller, Westin, Neyret and Hanrahan

Claims 34, 35, 49 and 50 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Gröller in view of Westin, and in further view of Neyret and Hanrahan et al. ("Reflection from Layered Surfaces due to Subsurface Scattering", ACM 1993, pages 165-174) (hereinafter "Hanrahan").

Claims 34, 35, 49 and 50 recite:

34. The method as defined in Claim 33, wherein:
the VRF represents the brightness of a voxel viewed from direction $V(\theta_v, \phi_v)$ when illuminated by a unit intensity light from direction $L(\theta_l, \phi_l)$;
the VRF is represented by a four-dimensional color array after discretization of the four angles $\theta_l, \phi_l, \theta_v, \phi_v$;
θ is a longitude angle; and
ϕ is an altitude angle.

35. The method as defined in Claim 34, wherein:

the discretization of the four angles $\theta_l, \phi_l, \theta_v, \phi_v$ comprises the discretization into directional increments;

the directional increments for the longitude angle are $\theta \in [0, 2\pi]$; and the directional increments of the altitude angle are $\phi_l \in [-\pi/2, \pi/2]$.

49. The medium as defined in Claim 48, wherein:

the VRF represents the brightness of a voxel viewed from direction $V(\theta_v, \phi_v)$ when illuminated by a unit intensity light from direction $L(\theta_l, \phi_l)$;

the VRF is represented by a four-dimensional color array after discretization of the four angles $\theta_l, \phi_l, \theta_v, \phi_v$;

θ is a longitude angle; and

ϕ is an altitude angle.

50. The medium as defined in Claim 49, wherein:

the discretization of the four angles $\theta_l, \phi_l, \theta_v, \phi_v$ comprises the discretization into directional increments;

the directional increments for the longitude angle are $\theta \in [0, 2\pi]$; and the directional increments of the altitude angle are $\phi \in [-\pi/2, \pi/2]$.

As discussed above, Gröller, Westin and Neyret, alone or in combination, fail to disclose or suggest the method recited in independent Claims 33 and 45. Hanrahan fails to cure the deficiencies of these three references.

Hanrahan describes a model for representing reflection from layered surfaces due to subsurface scattering. The model described in Hanrahan "is particularly appropriate for common layered materials appearing in nature, such as biological tissues (e.g. skin, leaves, etc.) or inorganic materials (e.g. snow, sand, paint, varnished or dusty surfaces)." (See Hanrahan, Abstract). Although the model in Hanrahan includes some angles variables, this model is not equivalent to the methods recited in Claims 34-35 and 49-50, which are applicable to voxels. Particularly, the claims recite that the VRF is represented by a four-dimensional color array after discretization of the four angles $\theta_l, \phi_l, \theta_v, \phi_v$. Hanrahan does not disclose or suggest such a four-dimensional color array.

For at least the above-identified reasons, Claims 34-35 and 49-50 are

patentable over Gröller, Westin, Neyret and Hanrahan, alone or in combination, and are allowable.

Conclusion

Claims 1-50 are in condition for allowance. Applicant respectfully requests the issuance of the subject application. Should any matter in this case remain unresolved, the undersigned attorney respectfully requests a telephone conference with the Examiner to resolve any such outstanding matter.

Respectfully Submitted,

Date: 9/14/2004

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